Cognitive competencies and learning objects

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Abstract

The purpose of this paper is reporting an experience of designing digital learning objects for university teaching.
The tasks consisted of participating in an electronic forum and developing teaching projects using simulation as a didactic tool. Both were mediated by the computer.
They took place in a postgraduate seminar.
The participants were university teachers and researchers from diverse areas – sciences, literature, arts and technology, performing varied academic tasks: teaching, research, consultation, and training.
Attendees were assisted via e - mail and by direct tutoring while participating in the discussion list and developing the projects, adopting a model of action – research.
Participants were asked to propose issues that could be discussed on - line. They chose three :

1.Is a digital mind or a digital intelligence conceivable? If so, how can we identify its traits?
2.Are creativity and digital learning contradictory or complementary processes?
3.How can electronic plagiarism in academic and research work be identified?

The themes were discussed one at a time in three courses.
Electronic simulation devices covered different subjects according to the discipline of the authors. The resulting projects were presented to teachers, tutors and peers in a collaborative atmosphere and evaluated by a checklist.

Key words: learning objects, cognitive competencies, triarchic theory,electronic forum, electronic simulation

Resumen

El propósito del artículo es informar sobre el diseño de objetos de aprendizaje para la enseñanza universitaria. Las tareas consistieron en la participación en un foro electrónico de discusión y en la elaboración de prototipos de simulación como herramienta didáctica. Ambas tareas, mediadas por la computadora se cumplieron en un seminario de postgrado. Los asistentes al seminario son docentes e investigadores universitarios provenientes de distintos campos del saber – ciencias, letras, artes y tecnología que desempeñan variadas labores académicas: enseñanza, investigación, consultoría, capacitación. Para el desarrollo de las tareas reciben tutoría directa y via email. El marco metodológico es el de la investigación – acción.
De las cuestiones para el foro de discusión planteadas por los destinatarios se eligieron:
¿Puede concebirse una “mente o inteligencia digital”? ¿Cómo diferenciar sus características?
La creatividad y el aprendizaje digital, son procesos contradictorios o complementarios?
¿Cómo detectar el plagio electrónico en el trabajo académico y en la investigación?
Los temas elegidos fueron discutidos en tres cursos uno por vez.
Los prototipos de simulación cubrieron distintas áreas según la disciplina de procedencia de los autores. Los proyectos fueron presentados a los pares, tutores y profesores en una atmósfera colaborativa y evaluados mediante una lista de control.

Palabras clave: objetos de aprendizaje, competencias cognitivas, teoría triárquica, foro electrónico, simulación electrónica

1. INTRODUCTION

"Although there is strong evidence that the Internet can provide resources to support good teaching and learning, there is no evidence that it can replace the role of teachers and peers. Our research and experience indicate the opposite: the universe of information has grown larger and more complex because of the extraordinary capabilities of new technologies. As a consequence, students need more than ever the guidance of experienced and skillful teachers to learn to their full potential"

Ally, M. (2000). *Open Praxis* (1), 31

The incorporation of new electronic communication devices to everyday life has been made by an important number of people and is a rapidly growing phenomenon (Covell, 1999).
Using e-mail and accessing Internet are not only forms of human interaction but ways of identifying social groups (Abbey,2000).
Building virtual environments demands a change in the current system of teaching and learning.
Conventional and electronic teaching and learning in higher education can be articulated in the curriculum. The challenge consists of making profit from the electronic innovations combining them with the usual practices in a curriculum model.
The new technologies impose changes in the students` activity, the role of the teachers and the strategies for implementing the curriculum.
Teachers and students need to master skills that the current curriculum may not address such as the ability to join diverse groups of people, to invent, share and master information directed to searching, assessing and filtering accurate information, and to making decisions based on incomplete information for solving novel problems (Gordon, 2000). Performing these competencies exceed the strict university context provoking changes in the mission of higher education.
From the standpoint of the student, autonomy and self-government are more necessary than ever. Abilities for searching, selecting, consulting, interpreting and using information coming from electronic means shape a particular profile.
With respect to the teacher, academic tutoring acquires great importance. Virtual communication asks for competencies not covered in the current teacher education.
A number of university teachers, as a result of age, do not have developed the same degree of familiarity with the new technologies as do younger generations (Bourne, 2000).
The university as a privileged source for producing knowledge and as a factor of progress for the society which sustains it, cannot be absent from these cultural changes.
Turning these aims into reality demands the habilitation of teachers as active actors in the university environment.
In the case of Argentine Universities, the incorporation of new technologies offers an alternative to affront problems such as overpopulated courses, inadequate infrastructure, limited time for direct interaction between teachers and students and rapid access to new information (Malbrán & Villar, 2000).

2. CONCEPTUAL FRAMEWORK

The development of high level cognitive abilities like critical and creative thinking, reasoning, and problem solving are considered important goals of University education. The computer – mediated

communication is an innovation in our university practice. The use of the Web is rather frequent for searching and exchanging information. Using it as a mediator for engaging in cognitive processes is much less frequent.
The conceptual framework based on the Triarchic Theory developed by R.J. Sternberg (1985 – 2004) draws on the paradigm of human intelligence as a complex way of processing information.
The Triarchic Theory (Sternberg, 1999) states that intelligence has three aspects: analytical, creative and practical. The paper includes the aspects considered more relevant according to the selected learning objects.
Content analysis according to the processes involved is one way of improving University teaching. A selected part of the subject matter, activity or task may be treated in terms of the Triarchic Theory focusing on the three kinds of thinking abilities:
- *analytical thinking*, useful for problem solving and decision making. Examples of these abilities are involved in skills for identifying a problem, allocating resources, representing and organizing data, formulating a strategy, monitoring the process and evaluating solutions. Information processing assumes mental representations and allocation of time. Metacomponents, higher order processes, refers to action planning, monitoring and evaluation. Performance components are seen trough inference and use of relations. Particularly pertinent to instruction are the knowledge acquisition processes involving in what the theory consider as insights: selective encoding, selective combination and selective comparison;
- *creative thinking*, involves coping with novelty taking the knowledge and handling routine activities to go beyond the information given. Abilities to invent, explore, discover, imagine, suppose, and dispositions such as flexibility, taking risks and seeing conventional issues in a different way, are in the core of creative thinking;
- *practical thinking*(Sternberg, 2000), assumes to discern individual strengths and weaknesses, making the most of strengths and compensating weaknesses. The experts of a given field have sharply developed this distinction. Practical thinking enables people to apply information to their academic and everyday life. Abilities used to apply, utilize, implement and activate knowledge and abilities pertain to the domain of practical thinking.
Successful intelligence is defined as the intellectual forces that permit to achieve individual goals in the sociocultural context where people live (Sternberg, 1997).
Sternberg (1986) strongly believes that all the three aspects can be developed .
He also states that if you are interested in fostering cognitive processes in others, you have to previously developed your own. This is the case of university teachers. An attempt to crystallize this principle was done by the use of the electronic discussion list or forum and by the design of simulated experiences.
Practical thinking can be viewed as a form of developing expertise. People who master the knowledge and abilities required for success in a particular domain are considered as experts.
Expertise is a label assigned to people who show cognitive, social and behavioral attributes valued as culturally adaptive.
Conceptions of expertise are useful to plan university teacher education. Expertise may be characterized as knowledge – based, the flexible application of the knowledge base, and the way the person is perceived by others. Knowledge seems to be a requisite for expertise.
Application demands the displaying of analytical, creative and practical skills.
Discussing the construct of mindfulness Sternberg (2000), mentions five traits: openness to novelty, alertness to distinction,defining the nature of a problem,sensitivity to different contexts, awareness of multiple perspectives (dialectical thinking),orientation in the present.
These traits may be put into action trough the discussion list and the design of simulated action. The forum also permits more experienced peers to support others.

The computer as a part of the cultural environment has inaugurated ways of accessing and treating information demanding abilities and dispositions that seem to be new, or at least a combination of the existing ones. It has generated reactions ranging from enthusiastic acceptance to open refusal. In spite of the growing familiarity with information networks, they are seen in some sectors as a new way of imposing patterns of thinking.
The use of electronic devices and information coming from other cultural contexts is skeptically approached, mainly if such devices and information are produced and distributed by international corporations. This perspective guards against blind acceptance. Cultural bias affects face validity and has to be taken into account when a virtual environment is being designed. Eco-cultural validity enables one to see the relevance of information from a foreign context to the local one (Burge, 2000.
Our experience points out the importance of the environment for producing ideas, and the role of human interaction as a trigger for activating creative processes.
Some material comes from local modes. The experience in graduate courses shows that the challenge of finding elements from the local needs and expectations is a motivational force in computer – mediated communication(Malbrán & Villar, 2001).

3. ACADEMIC CONTEXT

The National University of La Plata, Argentina, created the Teacher University Career in 1989.
The courses are aimed at university teachers –assistant and auxiliaries, coming from the sciences, the arts, the letters and the technology. One of the courses is a seminar entitled Development of University Teaching. It was conceived as an academic showcase for critical reflection, improvement and enrichment of educational practices.
Informal surveys give account of the scant use of the available communication technology both in undergraduate and graduate courses.
According to the objective of fostering reflection about teaching practice, the Triarchic Theory of Human Intelligence was adopted as a conceptual and methodological framework.
Controls of face, content and ecological validity were done in order to produce, select and adapt contextually suitable material.
Special consideration was given to metacomponents and insight processes.
Academic background and experience of the participants were revisited in terms of the contributions of the Triarchic Theory.
The selected aspects attracted attention from the teachers. They brought to the seminar examples and illustrations coming from academic life useful for designing curriculum strategies and activities (Malbrán & Villar, 2000/01).

4. ELECTRONIC TUTORING

Paradigmatic cases of direct tutoring can be found in the history of education. To mention well known examples: Alexander the Great and his master Aristotle, Leopold Mozart and his sons, Ann Sullivan and Helen Keller.
Electronic tutoring was implemented trough e-mail from 1999 onwards.
The responsibilities assigned to tutors were: helping to manage the learning process, motivate participants, provide rapid feedback, facilitate access to content, troubleshoot technical problems, use a variety of digital resources, guide formative evaluation.
At the beginning only a few participants were used to this tool and yet fewer were using it as a didactic resource.

This initially tiny group acted as a stimulus to other participants who progressively started communicating by electronic mail.
Both direct and e-mail tutoring advice and help participants in:
a. *Screen design*, as a support to lectures and demonstrations using criteria such as simplicity, attractiveness, synthetic power to communicate ideas.
The resulting screens were discussed by the entire group focused on their power to improve teaching.
b. *Icon selection* in terms of character, function, mental representations they may evoke, variables for designing, searching and adapting.
The icons were evaluated according to the symbolic power for complementing or substituting words, the degree of adequacy to the target or objective (face validity), the relevance for depicting the implied object, action or idea (content validity),perceptual clarity and simplicity, the significance for the context (ecological validity).
Participants were asked to rank the icons from the most to the less originality. Assigned values were then averaged. The ordering criteria were novelty,getting to the point, visual power of the image, ability to facilitate the grasp of the underlying idea.
c. *Knowledge of the Triarchic Theory*. The Monitor Triarchic Test was developed by adapting the multiple choice format as an interactive procedure and online assessment. It provides immediate feedback. Whenever the user chooses and incorrect alternative, a beep sounds. At the same time, a dialogue window tells the examinee if the selection was not correct. When the right alternative is chosen, a screen shows the underlying reasons for the correct option. In the same screen there is a form where the subject can make suggestions. Each item mentions the content source and indicates additional references. Completing the online test and deciding the moment of taking it, was optional.
d. *Accessing the Web* for searching and selecting relevant information. The use of the nets is rather frequent in the university context for searching and exchanging information. Using it as a mediator for displaying cognitive abilities is much less frequent.

5. THE ELECTRONIC FORUM

The electronic forum allows to display discussion, opinion, self – assessment, questioning, reformulating peer contributions and formulating new ideas based on the soundness in terms of the quality of sources and documentation (Kuhn, 1991).
The forum also permits more experienced peers to support others.
The online forum trough Internet was planned to acquaint participants with the use of the tool,identify the involved mental processes, distinguish facts, opinions and judgments, differentiate objective and subjective contributions, analyze potential uses in university education, profit from the academic knowledge and experience, build an interactive virtual environment, delimitate the responsibility of the users.
The major way in which arguers differ has to do with their understanding of the aims of the argumentation, to clearly distinguish between the opponent arguments from the opponent position. Skilled arguers show efficiency to identify and ordering lines of discussion, search and elaborate counterarguments, maintain the line of argumentation, avoid triviality and irrelevance, adapt strategies to the flow of discussion and anticipate others` position. Flexibility to consider alternative points of view and react accordingly is a disposition present in skilled arguers.
The task of the tutor or moderator is to enhance, underline and maintain the course of the dialogue to its aims, and to provoke understanding of the pursuedgoals.
Putting into action metacomponents enable people to plan, monitor and evaluate their contributions.

Looking for justification and proof for coping with the issue under discussion stimulates insights and creative ways of thinking.
Revising and changing individual position coming out form other perspectives claim for practical abilities.
According to Sternberg (1998), in order to understand human abilities one must consider the formulation of questions as important as the finding of answers. A critical point is to identify the important questions and which questions are supported by the available data.

5.1. Examples from the Discussion List

Theme: Is a digital mind or a digital intelligence conceivable? If so, how can we identify its traits?
Contributions embraced topics such as scope of the terms in a wide and strict sense, definition trials, mentioning of critical traits, historically related events, digital mind as a method, cultural invention and learning set, advantages and limitations of the digital mind, relationship man - machine.
The contributions showed three main conceptions about how the digital mind works: briefly stated, a combination of knowledge and abilities, a style of thinking and a methodology. It is useful to reflect on the diversity of the audience – university teachers coming from the sciences and humanities, whose perspectives enrich and add flexibility to the interaction.

Theme: How can electronic plagiarism in academic and research work be identified?
Comments, thoughts and suggestions made by participants: plagiarism existed long before the Internet; electronic plagiarism is a fact and a consequence of the advent of new technologies of communication and information. It represents a new challenge for teachers; copy and plagiarism are not the same : in spite of having diffuse boundaries, the second is an illegal appropriation of another`s production in order to be scientifically recognized, being published, receiving higher academic or research rankings, irrespective of the intellectual damage caused to the original author, the degree of awareness is a question of intellectual maturity that tends to increase with expertise,the more academically sophisticated the participants, the more difficult it is to detect plagiarism, it should be punished as a severe academic transgression,teachers and students should sign an honor code about the matter,the Internet should be freely used provided you mention the source, then the user has to put the new material on the net to be shared and consulted,punishment or legal regulations are not enough to control plagiarism, students have to be instructed about copyright, academic honesty and ethics, plagiarism is another trait of a society as bereft of ethical rules as ours, it is difficult to make boundaries between plagiarism and appropriate use of information in a world of continuous production of knowledge,programmes for detecting academic fraud can be based on
comparing information from Web pages with other sources that provide similar data, knowledgeable teachers and high level experts are more free from plagiarism, to detect mere reproduction demands an oral argument exposition, evaluation of sequencing, analysis, synthesis and critical judgment that assure understanding, paying attention to idiomatic expressions is a way to detect verbatim copy, teachers have to be trained in information technology, specifically in the use of links, nets and other digital sources, controlling the logic of the discourse in terms of consistency whole – parts, is useful to detect copying, and pasting, it is necessary to educate students as responsible Web users, not limiting their training to access to the nets, citing is not plagiarism, it is akin mentioning references or indexes,electronic plagiarism is similar to photocopying books and articles, a common practice in our academic culture,sometimes plagiarism is due to ignorance of copyright regulations, the Web is a part of our culture, a product that cannot be ignored. Then, users have to be taught to declare, frame, alter, mention and advantage of information that contributes to their

progress, some teachers ask for large and complex assignments that make it impossible for students to accomplish them within the time limits. So, they fall back on copy and paste, asking for personal opinions, conclusions, empirical and contrasting proof, and unconventional presentations prevent plagiarism, academic requirements such as rigorous treatment of bibliographies and citations, explanation of the basis and underlying principles, deepen the treatment of data, transcend the routines of copying and pasting, to elaborate upon a proposal or indicate a course of action is a way to move beyond the information given by the nets, frequently changing assignments and projects may be a tool to avoid plagiarism,the electronic interaction favored horizontal participation, frequency of contacts, spreading and feedback of ideas and a better time distribution than face to face meetings.
Criteria used to evaluate participation in the forum were: frequency of comments, contributions and interaction, frequency of being quoted by other participants, soundness, relevance, novelty, clearness and accuracy of arguments, quality of the documentation sources, contributions for enrichment the circulating information, consideration of alternative or controversial points of view.

6. ELECTRONIC SIMULATION

Simulation has a long tradition in education. The dialogue between
Socrates and the slave is a classical example. In the Socratic method the mediator (Socrates) pretends ignorance in a discussion aimed at exposing the fallacies in the individual's (slave) logic.
The expression "guided discovery" is an usual term that resembles the Socratic method of inquiry (De Jong et al., 1998)
Providing leading questions and examples, the learner is helped to arrive at new perspectives or experiences that challenge or change his/her practices.
The use of simulations and situational – judgment tests represents a set of attempts to capture real – world problem solving ability, implying practical intelligence (Sternberg, 2000).
Behaving as "if you were…", "or if you have to …", allows people to be acquainted with the situation and to be better prepared to develop appropriate responses to address the problem.
The design of simulated procedures presupposes the ability to predict possible courses of action for tackling the situation in a real-world environment (Herrington et al., 1999).
Simulated action calls for answering questions like "What would you do if …", or "What must be done when …" demanding probabilistic or relativistic thinking.
As the person is aware about the artificiality of the situation, simulation represents an intentional effort to solve the problem as though it were real.
Simulated practice may become a didactic strategy aimed at providing, under specified conditions, opportunities to experience phenomena, situations or events which can happen in real life.
It may be useful whenever the real environment is dangerous, the frequency of occurrence is low, the resources are scarce, costly or risky .
Teaching and learning based on problem solving through simulated tasks have a propædeutic value, facilitating information processing, giving opportunities for practice and improvement allowing for individual pace while facilitating the transfer of learning.
The transfer of learning apparently depends on the degree of similarity between the real and the virtual situation and constitutes a form of validation.
Simulation may cover different curricula areas such as knowledge attainment - declarative and procedural, acquisition of competencies and role playing.
The computer is a promising tool for designing and presenting simulated scenes. It may be viewed both as a learning and teaching method.
This technique calls for introducing representations in a predetermined model representing reality on a computer screen, bounded by the size of that screen.

Learning by simulation, both direct and electronically mediated, is always a virtual experience (Eisenberg et al., 1996).

As the computer has its own language and modus operandi, the design of computerized simulation entails customization and rewriting in this explicit language.

Simulations contribute to the study of mental abilities involved in teaching and learning. Task validity makes it possible to bridge the gap between the novice and the expert.

Face validity elicits interest and motivation from the learner.

Content is supposed to be representative for the subject.

The designers of simulated procedures mediated by the computer (Gredler, 1986) have to make decisions related to:

- content suitability and relevance ;
- content significance;
- amount and type of practice;
- provision of cues and feedback;
- monitoring and self – monitoring;
- degree of familiarity with the computer;
- previous experience with content and abilities;
- sequence disposition;
- kind of thinking -analytical, inductive and deductive.

Coming back to the Triarquic Theory of Human Intelligence (Sternberg, 1986), analytical intelligence entails analyzing problems before taking action, seeking and changing alternatives and stimulating the learner to build his/her own mental model following his/her path (metacomponents).

Creative intelligence is displayed by the processes of insight and discovery through immediate and direct feedback, in coping with new situations, in solving problems and inquiring beyond rote learning and passive listening.

Practical intelligence involves the learners` active participation and engagement, experience in decision making, foreseeing the consequences of action, group interaction and collaborative learning.

It is well known that virtual practice is not a substitute for actual experience. However, it represents an effective way to enhance the learning experience, giving opportunities to the student to become aware of personal limitations and other obstacles and sharing responsibility for advancement.

As a learning - teaching resource, simulation depends heavily on the quality of the design aimed at working with some issue prior to actual practice.

Decision making in simulation illustrates the mental model teachers have in mind and the ways for putting it into practice: graphics, assignments, diagnostic exercises, sequential decision making, procedures, situations, etc. It also demonstrates the role teachers assign to learners and to themselves during instruction.

7. SIMULATED EXPERIENCES

The Seminar on the Development of University Teaching included the design of simulation projects as a didactic tool. 80 teachers participated in the innovation. They were asked to select a subject applicable to their area of teaching and practice.

The participants presented the simulated experience in Power Point . The tutors helped to use this tool with didactic purposes.

The authors explained their projects in 10 minutes followed by 5 minutes for discussion, comments and suggestions with teachers, tutors and peers.

The Power Point presentation has several advantages as an instructional strategy: versatil, dynamic, attractive, appropriate for varied subjects, objects and tasks, easy to design,accessible in terms of technical requirements, includes animation as a means of representing information,
allows sequencing, segmentation and interactivity.
From the standpoint of the learner the simulation experiences demanded skills and activities focusing on the following areas: observing and focusing attention; reproducing, imitating, copying movements, techniques, maneuvers, words; taking action on the computer screen; rehearsing, coming to previous screens - moving back and forth; asking for help or extra information using links and navigation; selecting, producing and building the answers; monitoring progress; reviewing the whole procedure.
Electronic simulation devices covered various subjects according to the disciplines of the authors. The resulting projects were presented to teachers, tutors and peers in a collaborative atmosphere. It was allowed 10 minutes for explanation and 5 minutes fos discussion, comments and suggestions.
Some examples of simulation projects designed by the teachers are given below:
consequences of the Nuremberg Trial for International Law; interactive course for cardiac arrhythmia; self – evaluation module of pets`anatomy;
predicting factors of pests in summer and winter agriculture; medical emergency in cardiology and breathing access;dental therapy; rainfall drainage in home buildings.
The productions were evaluated by a checklist filled out by all participants.
A three point scale was prepared according to the following: extent the device simulates reality, sequencing of components or subtasks, indications for the navigation routes, advice for going through the program, focusing attention on critical points, provision of feedback, content significance,
specification of prerequisites, anticipation of mistakes, alternatives for revision, subsequent searching, goodness of fit with the computer language, relevance and attractiveness of screens, icons and cues.

8. CONCLUSIONS

The results show
- attitudinal changes reflected by pre and post seminar opinions,
- advantages of building a horizontal atmosphere, a relationship of equality between tutors and participants,
- an extended tutorial activity and scaffolding among peers,
- relevant and innovative contributions,
- multimedia productions, some of them illustrative of creative abilities.

The experience of including new technologies shows the possibility of articulating real and virtual models in university education and the need of preparing teachers accordingly.The quest for success calls for a careful consideration of the context, the kind of the audience and the extent of familiarity with regard to Internet.
The data provided by digital teaching and learning through electronic forum and projects of simulated learning will be integrated in a proposal for the building of a virtual model suitable for University education. The resulting model will be validated using a pilot implementation, consulting experts in the field of education and informatics and content analysis in terms of the implied cognitive processes and abilities.

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